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The Mineral Industry of India

UNITED STATES DEPARTMENT OF THE INTERIOR

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UNITED STATES DEPARTMENT OF THE INTERIOR • Donald Paul Hodel, Secretary

BUREAU OF MINES • Robert C. Horton, Director

This publication is a chapter from the current Bureau of Mines Minerals Yearbook, comprising *Volume I, Metals and Minerals; Volume II, Area Reports: Domestic; Volume III, Area Reports: International.* The separate volumes of the Yearbook are sold by the Superintendent of Documents, Washington, D.C. 20402.

The Mineral Industry of India

By Gordon L. Kinney[1]

India, the second most populous country in the world, was a major producer of a number of minerals and a major consumer of even more. Barite, cement, chromite, coal, iron ore, limestone, manganese, mica, mineral sands, and nitrogen fertilizer were all produced in significant amounts by world standards. A considerable amount of aluminum, copper, lead, and zinc were produced, but sizable imports of these metals were also needed to meet demand.

The industrial index of mineral production climbed in the first quarter of the year, dropped during the monsoon season, and climbed again at the return of good weather. Every month showed an increase over the same month of 1983, which was the same as the monthly relationship of 1983 and 1982. Overall, production rose an average of 10% over that of 1983. Metallic ore production was not as high but still showed an increase over that of 1983 in all but one month.

India's seventh 5-year plan, fiscal year (FY) 1985-89,[2] projected an economic annual growth continuing at 5%. It called for a total capital investment of $270 billion,[3] and emphasized irrigation, power generation, and oil and gas exploration and development.

The Oil and Natural Gas Commission (ONGC) was expected to get an outlay of about $15 billion, 2-1/2 times the amount for the sixth 5-year plan period. The intention was to increase crude oil output to 100 million tons by the year 2000. Three objectives were envisaged for ONGC by the Government: to achieve self-sufficiency in petroleum exploration, in oil technology, and in oil-related services and equipment production. In keeping with the plan, ONGC would permit Indian companies to enter into joint ventures with foreign oil companies and undertake contract drilling both onshore and offshore.

Chronic electric power shortages and stoppages have hindered the overall growth of the economy for a number of years. The mining and mineral processing industry has been particularly hard hit by these shortages by the very nature of their need for continuous operation. Solidification of hot metal because of a power failure causes damage to the furnace or ladle that is far more costly than the immediate metal production loss. Cement, fertilizer, petroleum, and petrochemical industries all suffer unique and expensive damage when the power stops. During 1984, 10 States were hit by major shortages. Bihar was the most affected with a 44% shortage. The normally power-surplus State of Kerala ended the year with a deficiency of 12%. It was difficult to estimate the damage of power disruptions to the economy, and the mineral industry in particular. A report by the Indian Federation of Chambers of Commerce estimated a loss of at least $16 billion in the last 3 years. In addition, a number of mining or mineral processing projects were probably not initiated in the knowledge that adequate electric power would not be available.

Both the central and State governments have been building new capacity at an impressive rate, adding an average of 10,000 megawatts in each of the last two 5-year planning periods. Demand, however, continued to grow at a similar or faster rate. The seventh 5-year plan called for an increase of 30,600 megawatts at a cost of $57 billion. Budgetary restraints, however, already have cut planned expenditures to $38 billion and a capacity increase of only 22,000 megawatts, only marginally more than the sixth plan (FY 1980-84) increase.

In an effort to utilize Indian resources more efficiently and to install additional power capacity quickly, the Government has made an important policy change. Util-

ization of natural gas for power generation was approved. The policy has been that natural gas could only be used for fertilizers, petrochemicals, and liquefied petroleum gas (LPG). However, offshore natural gas reserves have risen to the point where it was considered that their use for power generation would not deprive other industries of feedstock. The decision was made in part because nearly one-half of the current gas production has been flared for lack of a market. The Department of Power plans to set up gas turbine-powered generators at Kawas in Gujarat (580 megawatts), Sawai Madhopur in Rajasthan (375 megawatts), and Auriya in Uttar Pradesh (580 megawatts).

The Indian Bureau of Mines (IBM) has been preparing a series of comprehensive mineral maps for specific commodities. It planned to complete maps for bauxite, iron, and manganese during FY 1984. In preparation or scheduled were maps for fluorite, limestone, magnesite, and steatite. The IBM also planned to study the geology of small mines, which do not yet have surveys. Almost 80% of the working mines need such studies in order to proceed with exploration and development.[4]

Government organizations have been conducting basic mineral exploration in various parts of the country. The Geological Survey of India (GSI) has been evaluating gold prospects in several States, including Karnataka, Madhya Pradesh, Maharashtra, Tamil Nadu, and along the Himalayan foothills. The Atomic Mineral Division of the Atomic Energy Department has been surveying for uranium in Nagaland, Meghalaya, and in the West Kameng District of Arunachal Pradesh. Other areas of Arunachal Pradesh will come under a GSI program for basic geological mapping and mineral investigation. Only 33% of Arunachal Pradesh has been geologically mapped where GSI has found clays, coal, dolomite, graphite, limestone, and marble.

The Government awarded a contract to a Canadian firm for airborne natural resource surveys and processing of the resulting data. The main equipment will be a DHC-6 Twin Otter aircraft with a multisensor airborne geophysical system. In addition, Indian technical personnel will be trained to operate and maintain the aircraft and equipment.

PRODUCTION

The mineral industry had a generally good year, increasing production 10% over the 1983 output. Several sectors that did better than average were aluminum, barite, cement, copper, and gypsum. Production of coal, natural gas, and oil continued to increase. The value of hydrocarbon production increased an estimated 11% over that of 1983, and represented over 90% of the total mineral industry value. Metals and nonmetals were about equal in value and accounted for less than 5% each of the mineral value. The increased production of aluminum and copper was a result of improved power supplies, some from newly installed on-site captive powerplants.

Currently, natural gas is underused and mostly flared. However, natural gas utilization was expected to increase dramatically during the seventh plan period as fertilizer, petrochemical, and gas-turbine electric powerplants come on-line.

Coal production reached a record high, which was a 7% increase over the previous record high of 1983. Dispatches, however, were 119 million tons resulting in pithead stocks of more than 30 million tons at the end of FY 1984.

Table 1.—India: Production of mineral commodities[1]

(Metric tons unless otherwise specified)

Commodity[2]	1980	1981	1982	1983	1984[p]
METALS					
Aluminum:					
Bauxite, gross weight thousand tons	1,785	1,923	1,854	1,923	1,994
Alumina, gross weight[e] do.	500	500	500	450	560
Metal, primary	184,838	212,844	216,679	203,559	268,520
Cadmium metal	89	113	131	131	[e]120
Chromium: Chromite, gross weight	319,538	334,681	339,196	422,000	435,000
Copper:					
Mine output, metal content	27,600	25,200	24,000	37,774	44,132
Metal:					
Smelter	28,489	25,743	32,585	[3]35,469	37,001
Refined (cathode, not including secondary)	[r]24,564	[r]24,036	[r]25,632	28,368	32,580
Gold metal, smelter troy ounces	78,834	79,875	71,935	70,158	65,234
Iron and steel:					
Iron ore and concentrate:					
Gross weight thousand tons	41,936	41,354	40,902	38,800	41,026
Iron content do.	26,252	25,888	25,605	24,289	25,682
Metal:					
Pig iron do.	8,493	9,474	9,600	9,086	9,382
Ferroalloys:					
Ferrochromium	[r]16,494	[r]31,905	40,244	31,119	[e]40,000
Ferromanganese	[r]158,303	[r]205,571	150,707	125,594	[e]125,000
Ferrosilicochromium	[r]4,050	[r]4,339	[e]4,000	11	[e]100
Ferrosilicon	[r]54,319	[r]60,354	36,060	41,187	[e]40,000
Other	535	9,074	[e]14,000	[e]11,000	[e]10,000
Steel, crude:					
Steel ingots thousand tons	9,358	10,300	10,628	10,216	[e]10,261
Steel castings do.	[e]65	[e]80	87	89	[e]86
Total do.	[e]9,423	[e]10,380	10,715	10,305	[e]10,347
Semimanufactures[3] do.	[e]6,740	6,600	[4]6,565	[4]6,511	[4]6,967
Lead:					
Mine output, metal content	12,720	15,320	16,640	25,700	24,839
Metal, refined:					
Primary	14,846	14,325	14,413	14,960	15,246
Secondary	10,732	11,081	8,780	6,596	[e]10,000
Total	25,578	25,406	23,193	21,556	[e]25,246
Manganese ore and concentrate, gross weight thousand tons	1,692	1,526	1,448	1,320	1,081
Rare-earth metals: Monazite concentrate, gross weight[e]	3,395	3,704	4,000	4,000	4,000
Selenium kilograms	4,148	4,104	5,351	3,684	[e]4,000
Silver, mine and smelter output thousand troy ounces	366	555	463	469	862
Titanium concentrates, gross weight:					
Ilmenite	[3]167,900	162,514	[r 3]152,938	[3]134,476	[e]140,000
Rutile	[3]5,360	6,710	[r 3]5,782	[3]5,500	[e]6,000
Tungsten, mine output, metal content	22	18	25	15	21
Zinc:					
Mine output, concentrate:					
Gross weight	46,489	52,876	52,839	77,594	92,968
Metal content	26,457	29,082	29,060	40,350	48,343
Metal:					
Primary	43,627	57,434	52,571	53,268	55,753
Secondary	234	[e]200	[e]200	[e]200	[e]200
Total	43,861	57,634	52,771	53,468	55,953
Zirconium concentrate: Zircon, gross weight	14,820	12,400	10,483	11,395	[e]12,000
NONMETALS					
Abrasives, natural, n.e.s.:					
Corundum, natural	1,454	1,292	1,355	714	[e]500
Garnet	3,742	3,176	5,429	3,349	[e]3,000
Jasper	4,117	3,356	2,139	5,418	[e]5,000
Asbestos	31,253	24,515	26,761	24,873	25,450
Barite	434,015	353,362	325,368	323,000	446,000
Bromine, elemental	334	350	[e]350	[e]350	[e]350
Cement, hydraulic thousand tons	17,700	20,760	22,498	25,400	29,030
Chalk	87,142	85,309	87,057	91,146	[e]80,000
Clays:					
Ball clay	125,457	118,635	114,782	137,917	[e]135,000
Diaspore	5,504	6,099	5,802	6,361	[e]6,000
Fire clay	656,279	791,105	769,495	657,000	602,000

See footnotes at end of table.

Table 1.—India: Production of mineral commodities[1] —Continued

(Metric tons unless otherwise specified)

Commodity[2]	1980	1981	1982	1983	1984[p]
NONMETALS —Continued					
Clays —Continued					
Kaolin:					
Direct salable, crude thousand tons	355	392	531	553	623
Processed do.	105	114	e100	e100	e100
Total do.	460	506	e631	e653	723
Other do.	80	80	e80	e80	e80
Diamond:					
Gem[e] thousand carats	12	14	11	12	13
Industrial[e] do.	2	2	2	2	2
Total do.	14	16	13	14	15
Feldspar	58,610	59,395	44,854	41,837	e45,000
Fluorspar:					
Concentrates:					
Acid-grade	12,349	13,346	12,407	e11,000	e12,000
Metallurgical-grade	4,809	5,374	5,710	4,590	e5,000
Total	17,158	18,720	18,117	e15,590	e17,000
Other fluorspar materials, graded	4,049	4,185	6,785	6,993	e7,000
Gem stones excluding diamond:					
Agate including chalcedony pebble	1,379	1,476	1,062	502	e1,000
Emerald, crude carats	6,600	1,000	--	--	--
Garnet kilograms	3,726	1,539	2,249	735	e2,000
Graphite[3]	r54,960	r72,796	52,376	39,567	e40,000
Gypsum	866,228	947,663	970,365	1,039,000	1,378,000
Kyanite and related materials:					
Andalusite	--	146	536	2,573	e2,000
Kyanite	46,522	38,283	33,951	38,307	37,024
Sillimanite	12,987	10,254	13,066	7,928	13,377
Lime[e]	400,000	400,000	400,000	400,000	500,000
Magnesite	380,113	453,410	407,071	434,072	403,000
Mica:[4]					
Exports:					
Block	788	1,184	e1,100	r e1,100	e1,100
Film and book for M cuttings	328	348	e200	r e200	e200
Splittings	1,636	3,313	e4,000	r e3,000	e3,000
Scrap	7,077	6,475	e8,000	r e7,000	e7,000
Powder	14,005	11,646	e5,000	r e4,000	e4,000
Manufactured	1,752	420	e300	r e500	e500
Total	25,586	23,386	e18,600	r e15,800	e15,800
Domestic use, all forms[e]	3,000	3,000	3,000	3,000	3,000
Total mica	28,586	26,386	e21,600	r e18,800	e18,800
Nitrogen: N content of ammonia[3] thousand tons	2,221	3,193	3,469	3,560	3,900
Phosphate rock including apatite	540,932	561,944	559,986	687,907	892,000
Pigments, mineral, natural: Ocher	86,198	79,631	84,789	88,633	e90,000
Pyrites, gross weight	83,806	57,598	55,853	63,621	44,238
Salt:					
Rock salt thousand tons	5	4	4	4	5
Other do.	8,004	8,928	7,308	7,008	7,725
Total do.	8,009	8,932	7,312	7,012	7,730
Sodium carbonate	524,644	613,000	586,800	744,329	e720,000
Stone, sand and gravel:[7]					
Calcite	24,028	21,167	19,101	e20,000	e20,000
Dolomite thousand tons	1,887	1,955	2,133	2,264	2,277
Limestone do.	28,215	30,873	33,462	36,965	45,483
Quartz and quartzite do.	240	282	332	e300	e300
Sand:					
Calcareous do.	772	685	669	598	570
Other do.	1,532	e1,400	1,254	1,018	e1,200
Slate	11,406	9,187	4,770	3,461	e5,000
Sulfur:					
Content of pyrites	33,522	23,039	22,341	25,448	17,695
Byproduct:					
From metallurgical plants[e]	115,000	92,000	100,000	110,000	115,000
From oil refineries	5,065	4,170	5,189	3,906	e5,000
Total[e]	153,587	119,209	127,530	139,354	137,695

See footnotes at end of table.

Table 1.—India: Production of mineral commodities[1] —Continued

(Metric tons unless otherwise specified)

Commodity[2]	1980	1981	1982	1983	1984[p]
NONMETALS —Continued					
Talc and related materials:					
Pyrophyllite	34,102	38,420	43,602	59,042	e60,000
Steatite (soapstone)	335,455	329,149	300,338	294,000	e300,000
Vermiculite	3,428	3,624	2,068	2,411	e2,500
Wollastonite	5,788	15,940	20,725	16,557	e20,000
MINERAL FUELS AND RELATED MATERIALS					
Coal:					
Bituminous thousand tons	114,010	124,900	128,225	136,261	145,800
Lignite do.	4,548	5,500	6,675	7,342	7,500
Total do.	118,558	130,400	134,900	143,603	153,300
Coke:[4]					
Coke oven and beehive do.	12,000	12,000	12,000	12,000	12,000
Gashouse do.	100	100	100	100	100
Other, soft do.	50	50	50	50	50
Total do.	12,150	12,150	12,150	12,150	12,150
Gas, natural:					
Gross million cubic feet	82,530	[3]136,067	140,000	210,550	e211,000
Marketable[5] do.	50,661	[3]75,820	85,180	100,860	114,420
Petroleum:					
Crude thousand 42-gallon barrels	75,672	116,712	149,811	184,440	204,943
Refinery products:					
Gasoline do.	12,393	22,691	NA	27,100	e26,000
Kerosine and jet fuel do.	18,440	22,529	NA	27,900	e27,000
Distillate fuel oil do.	60,680	74,555	NA	87,200	e84,000
Residual fuel oil do.	41,845	46,307	NA	53,600	e51,000
Lubricants do.	} e57,642	2,849	NA	3,200	e3,000
Other do.		42,176	NA	43,600	e42,000
Refinery fuel and losses do.		13,594	NA	20,200	e19,000
Total do.	e191,000	224,701	e240,000	262,800	e252,000

eEstimated. pPreliminary. rRevised. NA Not available.

[1]Table includes data available through Sept. 10, 1985.

[2]In addition to the commodities listed, other clays (bentonite, fuller's earth, and common clays), other gem stones (aquamarine, ruby, and spinel), and uranium are also produced, but output is not reported, and available information is inadequate to make reliable estimates of output levels. In 1975, production of 6,514 metric tons of uranium ore containing about 3 metric tons of U_3O_8 was reported from two mines, which was only a part of total national production. Reported production of sand and gravel and stone are clearly only partial figures and exclude a number of types of stone; the amounts reported are inadequate to provide sufficient aggregate for production of concrete from domestically produced and consumed cement, nor do they provide for other supplies of aggregate for road metal and other construction uses.

[3]Data are for fiscal year beginning Apr. 1 of that stated.

[4]Excludes production from steel miniplants.

[5]India marketable production is 10% to 20% of mine production.

[6]Data supplied here (exports plus domestic use) are provided in lieu of officially reported production because the latter figures are evidently incomplete. Officially reported production figures are as follows, in metric tons: 1980—12,355; 1981—12,729; 1982—12,961; 1983—7,364; and 1984—7,171.

[7]Partial figures; for details, see footnote 2.

[8]Includes reinjected gas.

TRADE

The foreign trade deficit dropped from $5.7 billion to $4.3 billion for a 25% improvement over that of 1983. The improvement was due mainly to the 3.5-million-ton increase in crude oil production, which in turn allowed a corresponding decline in net petroleum imports. India's main export commodity by value was cut diamonds, obtained by importing the rough stones. Iron ore continued to be a major export item but has been decreasing because of the world economic situation and because of a controversy over higher ore handling and other charges at the export docks. Both problems were settled or improved by year-end.

The only important proposal in the central Government budget concerning the mineral sector related to the abolition of export duties on chrome, iron and manganese ores, manganese dioxide, sillimanite, kyanite, and some types of mica. The policy was to be effective in March 1985 and was designed to promote exports of these minerals.

Table 2.—India: Exports and reexports of selected mineral commodities[1]

(Metric tons unless otherwise specified)

Commodity	1980	1981	Destinations, 1981	
			United States	Other (principal)
METALS				
Aluminum:				
Ore and concentrate	131,587	118,718	--	Saudi Arabia 60,952; United Arab Emirates 50,236; U.S.S.R. 5,555.
Oxides and hydroxides	1,202	428	--	Kenya 336; Republic of Korea 34.
Metal including alloys, all forms	4,962	25,267	56	Sri Lanka 10,246; Malaysia 9,577; U.S.S.R. 1,894.
Antimony: Ore and concentrate	812	--	--	
Chromium: Ore and concentrate	129,981	75,075	--	Japan 59,500; China 15,575.
Cobalt: Oxides and hydroxides	38	70	--	France 30; Kuwait 11.
Copper:				
Ore and concentrate	11,011	--	--	
Metal including alloys, all forms	2,205	528	(2)	Bangladesh 339; United Kingdom 46.
Iron and steel:				
Iron ore and concentrate including roasted pyrite -- thousand tons	25,210	19,477	--	Japan 12,619; Romania 3,123; Republic of Korea 2,050.
Metal:				
Scrap	1,675	20,221	--	Japan 17,278; Saudi Arabia 2,037.
Pig iron, cast iron, related materials	1,936	1,818	603	Australia 458; Thailand 276.
Ferroalloys	12,261	4,178	--	Qatar 3,000; Oman 1,107.
Steel, primary forms	7,675	2,091	--	Nepal 1,823; U.S.S.R. 157; Japan 62.
Semimanufactures:				
Bars, rods, angles, shapes, sections	29,267	6,802	938	Egypt 2,444; Bangladesh 686; Iran 678.
Universals, plates, sheets	7,473	436	--	Egypt 167; Nepal 111; Kuwait 56.
Hoop and strip	20	34	--	U.S.S.R. 13; Iran 9; Iraq 6.
Rails and accessories	652	978	17	Iraq 330; Sudan 281; Bangladesh 137.
Wire	16,242	3,884	14	Bahrain 1,009; Iraq 611; Iran 565.
Tubes, pipes, fittings	104,232	103,844	9,802	Saudi Arabia 26,201; Iran 11,471; Iraq 7,008.
Castings and forgings, rough	6,381	8,103	4,856	Canada 836; Saudi Arabia 725; Egypt 393.
Manganese:				
Ore and concentrate	568,424	421,028	--	Japan 322,889; Republic of Korea 41,700; Czechoslovakia 16,500.
Oxides	673	203	--	Sri Lanka 175.
Titanium: Oxides	238	102	54	Kenya 42.
Zinc:				
Oxides	250	143	66	Iraq 50; Sri Lanka 27.
Metal including alloys, all forms	297	387	1	Sri Lanka 364.
Other: Ores and concentrates	1,321	10	10	
NONMETALS				
Abrasives, n.e.s.:				
Natural: Corundum, emery, pumice, etc	1,065	2,641	10	Japan 2,370.
Artificial: Corundum	47	68	--	All to Republic of Korea.
Grinding and polishing wheels and stones	3,462	43,381	19	Saudi Arabia 39,240; China 1,034; Thailand 794.
Barite and witherite	341,348	135,590	29,219	Mexico 41,334; United Arab Emirates 31,070; Iraq 12,000.
Cement	32,413	1,151	--	Nepal 1,076.
Chalk	1,024	153	--	Kuwait 50; Bahrain 25; Oman 21.
Clays, crude	20,547	21,060	9	Kenya 5,669; Saudi Arabia 4,637; United Arab Emirates 3,586.
Diamond: Gem, not set or strung thousand carats	(2)	3,042	896	Belgium-Luxembourg 585; Hong Kong 359; Japan 325.
Feldspar	182,272	17,303	--	Singapore 4,691; Malaysia 4,675; Bangladesh 1,861.
Fertilizer materials: Manufactured, nitrogenous	10,208	--	--	
Graphite, natural	3,476	3,491	455	Japan 966; China 612; United Kingdom 569.
Gypsum and plaster	9,223	4,583	--	Sri Lanka 2,435; Nepal 1,200.
Kyanite and related materials	NA	645	--	All to Japan.

See footnotes at end of table.

Table 2.—India: Exports and reexports of selected mineral commodities[1] —Continued

(Metric tons unless otherwise specified)

Commodity	1980	1981	Destinations, 1981	
			United States	Other (principal)
NONMETALS —Continued				
Magnesium compounds: Magnesite	6,788	2,065	79	United Kingdom 903; Sri Lanka 350; West Germany 200.
Mica:				
Crude including splittings and waste	11,551	11,695	2,806	Japan 3,337; East Germany 1,184; Czechoslovakia 816.
Worked including agglomerated splittings	15,755	12,065	620	West Germany 1,983; Japan 1,713; Poland 1,193.
Pigments, mineral: Natural, crude	371	--		
Precious and semiprecious stones other than diamond:				
Natural value, thousands	$38,100	$19,432	$4,394	Hong Kong $2,034; Italy $1,846; West Germany $1,585.
Synthetic do.	$457	$719	$205	Italy $115; United Kingdom $84; Thailand $75.
Salt and brine	47,363	61,833	--	Nepal 36,406; Kenya 14,160; Bangladesh 8,807.
Sodium compounds, n.e.s.: Sulfate, manufactured	6,742	50	--	All to Malaysia.
Stone, sand and gravel:				
Dimension stone:				
Crude and partly worked	341,928	365,727	566	Japan 133,571; Bangladesh 69,753; Italy 55,333.
Worked	13,550	4,955	1	United Arab Emirates 3,191; Netherlands 707.
Dolomite, chiefly refractory-grade	8,151	5,503	--	Bangladesh 3,530; Qatar 845; United Arab Emirates 439.
Gravel and crushed rock	30,761	6,218	--	Kuwait 3,690; United Arab Emirates 1,879.
Limestone other than dimension	194,966	205,075	--	Bangladesh 179,968; Malaysia 8,838; Singapore 5,683.
Quartz and quartzite	16,092	38,004	--	Japan 37,249.
Sand other than metal-bearing	4,229	10,363	--	United Kingdom 8,999; Pakistan 784.
Talc, steatite, soapstone, pyrophyllite	11,087	8,150	56	Kenya 2,955; Bangladesh 998; Norway 920.
Vermiculite	3,117	62	--	China 50; Japan 10.
Other: Crude	1,180	1,985	3	Netherlands 500; Republic of Korea 271; West Germany 232.
MINERAL FUELS AND RELATED MATERIALS				
Asphalt and bitumen, natural	122	2	--	All to United Arab Emirates.
Carbon: Carbon black	659	330	--	Sri Lanka 300.
Coal: All grades including briquets	113,877	142,910	--	Bangladesh 104,757; Nepal 38,153.
Coke and semicoke	2,302	--		
Petroleum refinery products:				
Gasoline 42-gallon barrels	NA	486,753	NA	NA.
Kerosine and jet fuel do.	NA	540,973	NA	NA.
Distillate fuel oil do.	813,998	41,328	NA	NA.
Unspecified do.	25,256	--		

NA Not available.
[1]Table prepared by Audrey D. Wilkes.
[2]Less than 1/2 unit.
[3]Unreported quantity valued at $535,069,000.

Table 3.—India: Imports of selected mineral commodities[1]

(Metric tons unless otherwise specified)

Commodity	1980	1981	Sources, 1981	
			United States	Other (principal)
METALS				
Aluminum: Metal including alloys:				
Scrap	NA	22,615	20,757	Singapore 461; Australia 390.
Unwrought	86,535	30,241	15,146	United Arab Emirates 6,316; Netherlands 4,416; Egypt 2,002.
Semimanufactures	22,072	20,395	4,581	Hong Kong 5,671; Venezuela 5,662; Spain 1,309.

See footnotes at end of table.

Table 3.—India: Imports of selected mineral commodities[1] —Continued

(Metric tons unless otherwise specified)

Commodity	1980	1981	Sources, 1981	
			United States	Other (principal)
METALS —Continued				
Antimony: Oxides	[2]45	98	1	United Kingdom 69; West Germany 19.
Arsenic: Oxides and acids	[2]171	318	--	France 255; United Kingdom 48.
Cobalt: Oxides and hydroxides	[2]750	1,679	3	Netherlands 1,000; Belgium-Luxembourg 525.
Copper:				
Ore and concentrate	7,364	16,613	9,708	Philippines 6,905.
Metal including alloys:				
Scrap	[2]31,767	39,367	12,433	Singapore 8,941; Kuwait 4,378; United Arab Emirates 3,544.
Unwrought	45,047	48,983	288	Zambia 20,508; Tanzania 18,549; Zaire 2,453.
Semimanufactures	5,659	15,693	1,038	France 3,603; Japan 3,148; United Kingdom 2,230.
Iron and steel: Metal:				
Scrap	112,605	519,918	226,677	United Kingdom 161,997; Netherlands 66,636.
Pig iron, cast iron, related materials	1,817	120,155	10,331	China 43,157; Indonesia 28,270; Pakistan 20,331.
Ferroalloys	7,593	8,160	31	United Kingdom 5,145; Singapore 620; France 404.
Steel, primary forms	170,031	168,612	1,629	West Germany 67,756; China 36,943; United Kingdom 15,126.
Semimanufactures:				
Bars, rods, angles, shapes, sections	346,672	518,323	10,323	Japan 144,103; United Kingdom 84,735; Republic of Korea 82,206.
Universals, plates, sheets	801,189	1,725,743	83,440	West Germany 362,484; Spain 209,765; Japan 204,394.
Hoop and strip	16,936	14,532	463	West Germany 4,641; Japan 2,970; Belgium-Luxembourg 2,352.
Rails and accessories	25,872	19,883	8	Austria 5,442; West Germany 4,199; Belgium-Luxembourg 3,753.
Wire	4,440	9,089	191	Belgium-Luxembourg 2,946; Japan 1,559; Italy 1,091.
Tubes, pipes, fittings	85,681	97,336	1,184	Japan 49,971; West Germany 16,373; France 5,328.
Castings and forgings, rough	1,653	2,450	15	Japan 1,037; West Germany 951; United Kingdom 257.
Lead: Metal including alloys:				
Scrap	[2]2,736	5,806	549	United Arab Emirates 1,972; Kuwait 973; Australia 725.
Unwrought	19,518	18,336	102	Australia 16,180; West Germany 1,248.
Semimanufactures	238	46	NA	Australia 41.
Manganese:				
Ore and concentrate, battery-grade	11,444	3,790	--	Singapore 2,930; Japan 760.
Oxides	[2]482	731	--	Belgium-Luxembourg 389; Japan 203; United Kingdom 80.
Mercury 76-pound flasks	[2]8,697	9,552	1,001	Finland 2,901; Netherlands 1,918; China 1,751.
Molybdenum: Ore and concentrate	[2]163	172	28	Japan 43; Netherlands 29; Switzerland 25.
Nickel: Metal including alloys:				
Scrap	[2]1,647	2,870	85	West Germany 619; Netherlands 532; Belgium-Luxembourg 326.
Unwrought	2,225	6,720	175	Canada 1,561; United Kingdom 1,501; Australia 659.
Semimanufactures	1,864	1,411	37	United Kingdom 381; Spain 300; Australia 141.
Platinum-group metals: Metals including alloys, unwrought and partly wrought troy ounces	[2]12,392	8,406	54	United Kingdom 4,577; U.S.S.R. 3,009.
Rare-earth metals including alloys, all forms kilograms	[2]5,080	1,118	368	Japan 750.
Selenium, elemental	[2]15	26	([3])	Japan 19; United Kingdom 2.
Silicon, high-purity	[2]672	1,351	5	France 535; Norway 431; China 160.

See footnotes at end of table.

Table 3.—India: Imports of selected mineral commodities[1] —Continued

(Metric tons unless otherwise specified)

Commodity	1980	1981	Sources, 1981	
			United States	Other (principal)
METALS —Continued				
Silver:				
Waste and sweepings[4] value, thousands	NA	$92	$22	Bahrain $70.
Metal including alloys, unwrought and partly wrought troy ounces	(5)	18,494	580	West Germany 8,848; East Germany 8,038; United Kingdom 1,000.
Tin:				
Oxides	[2]13	11	--	Japan 8; West Germany 1; United Kingdom 1.
Metal including alloys:				
Scrap	[2]1,366	2,649	398	United Kingdom 1,046; Belgium-Luxembourg 846.
Unwrought	1,546	2,351	--	Malaysia 2,050; Singapore 300.
Semimanufactures	25	5		West Germany 4.
Titanium: Oxides	[2]5,425	9,397	1,576	United Kingdom 4,295; Australia 966; Japan 876.
Tungsten: Ore and concentrate	[2]376	446	--	Switzerland 153; Canada 96; Thailand 85.
Zinc:				
Ore and concentrate	40,845	--		
Metal including alloys:				
Scrap	[2]4,115	3,371	1,936	Australia 572; Singapore 270; Belgium-Luxembourg 263.
Unwrought	51,882	59,806	46	Zaire 9,324; Zambia 8,704; Canada 8,487.
Semimanufactures	1,234	227	35	West Germany 77; Netherlands 49; Japan 34.
Other:				
Ores and concentrates	712	147	--	Belgium-Luxembourg 73; West Germany 15; United Kingdom 14.
Oxides and hydroxides	[2]848	2,338	518	West Germany 603; Belgium-Luxembourg 288; Japan 237.
Ashes and residues	[2]3,938	8,792	3,256	Australia 3,296; Kenya 725.
NONMETALS				
Abrasives, n.e.s.:				
Dust and powder of precious and semi-precious stones including diamond kilograms	[2]191	426	138	U.S.S.R. 94; United Kingdom 76.
Grinding and polishing wheels and stones	439	231	36	West Germany 53; Japan 37.
Asbestos, crude	54,590	42,779	1,381	Canada 21,191; U.S.S.R. 11,541; Republic of South Africa 3,086.
Boron materials:				
Crude natural borates	[2]2,713	3,477	377	Turkey 3,100.
Oxides and acids kilograms	[2]9,560	3,511	406	Japan 3,105.
Bromine	[2]20	466	--	Israel 318; United Kingdom 80.
Cement	1,728,067	880,523	43,735	Republic of Korea 468,859; North Korea 221,967; Indonesia 71,391.
Clays, crude	[2]5,380	824	121	United Kingdom 475; West Germany 174.
Diamond:				
Gem, not set or strung value, thousands	$513,852	$515,812	$5,990	Belgium-Luxembourg $277,922; United Kingdom $182,285; Switzerland $33,663.
Industrial stones do	$969	$834	$108	United Kingdom $355; Belgium-Luxembourg $281.
Feldspar, fluorspar, related materials	[2]5,279	272	--	Thailand 240; United Kingdom 26.
Fertilizer materials: Manufactured:				
Ammonia	[2]111,772	173,298	(3)	Kuwait 98,893; Qatar 66,367.
Nitrogenous	1,959,460	1,494,962	233,262	Netherlands 330,640; Qatar 152,040.
Phosphatic	186,342	201,570	182,791	Jordan 18,779.
Potassic	813,605	792,173	31,315	West Germany 367,497; Canada 302,914; East Germany 57,593.
Unspecified and mixed	492,046	236,378	157,912	Canada 48,234; West Germany 19,636; U.S.S.R. 10,500.
Graphite, natural	[2]132	219	(3)	Japan 172; West Germany 37.
Iodine	[2]159	115	(3)	Japan 88; Belgium-Luxembourg 23.

See footnotes at end of table.

Table 3.—India: Imports of selected mineral commodities[1] —Continued

(Metric tons unless otherwise specified)

Commodity	1980	1981	Sources, 1981	
			United States	Other (principal)
NONMETALS —Continued				
Magnesium compounds: Magnesite	[2]22,752	1,303	3	Austria 515; Republic of Korea 308; Czechoslovakia 200.
Mica: Worked including agglomerated splittings	[2]58	14	([3])	West Germany 5; United Kingdom 5; Switzerland 3.
Phosphates, crude	[2]844,764	9[r]5,257	152,729	Jordan 433,252; Morocco 288,711; Senegal 53,027.
Precious and semiprecious stones other than diamond:				
Natural value, thousands	$13,113	$16,406	$3,990	United Kingdom $4,044; Switzerland $3,073.
Synthetic do.	$605	$352	$86	France $92; Switzerland $76.
Sodium compounds, n.e.s.:				
Carbonate, manufactured	[2]93,477	102,857	42	Bulgaria 61,728; Romania 29,871.
Sulfate, manufactured	[2]141	973	--	China 764; Belgium-Luxembourg 105; Singapore 96.
Sulfur: Elemental, crude including native and byproduct	676,604	592,261	147,441	Canada 134,887; Israel 109,363; Mexico 74,311.
Other:				
Crude	[2]838	8,203	18	Republic of Korea 4,986; Turkey 3,000.
Slag and dross, not metal-bearing	[2]5,353	78,569	17,289	United Kingdom 60,431.
MINERAL FUELS AND RELATED MATERIALS				
Asphalt and bitumen, natural	[2]10,070	5,032	158	Singapore 4,800.
Carbon: Carbon black	[2]5,685	17,559	1,928	Australia 8,911; China 2,468; Thailand 2,517.
Coal: All grades including briquets	391,482	176,252	29,881	Australia 107,104; Canada 38,213.
Petroleum:				
Crude thousand 42-gallon barrels	118,702	114,734	--	Iran 44,993; Saudi Arabia 21,062; United Arab Emirates 13,911.
Refinery products:				
Liquefied petroleum gas value, thousands	$2,637	$2,313	$8	Saudi Arabia $2,305.
Gasoline thousand 42-gallon barrels	2	2,341	NA	NA.
Kerosine and jet fuel do.	41	34,223	NA	NA.
Distillate fuel oil do.	9	7,656	NA	NA.

NA Not available.
[1]Table prepared by Audrey D. Wilkes.
[2]Quantity represents 11 months' data.
[3]Less than 1/2 unit.
[4]May include other precious metals.
[5]Unreported quantity valued at $121,000.

COMMODITY REVIEW

METALS

Bauxite, Alumina, and Aluminum.—During the last few years, the Indian aluminum industry has suffered production problems owing basically to the continual shortages and frequently unannounced power outages. During 1984, captive powerplants were being allowed by the Government for major power-intensive industries such as the aluminum industry, whose production suffered because of inadequate power. Hindustan Aluminium Co. Ltd. (HINDALCO) had just completed installation of enough captive capacity to meet 90% of its power requirements. A captive 270-megawatt thermal powerplant was under construction for Bharat Aluminium Co. (BALCO), which was expected to be completed in 3 years. National Aluminium Co. Ltd. (NALCO) was installing total captive power as part of its original design. These measures should go a long way toward ensuring uninterrupted power supplies and thereby improving smelter utilization. During 1984, the power situation improved, allowing a substantial increase in aluminum production over that of 1983.

India's 362,000-ton-per-year smelter capacity will be increased considerably when

NALCO's 218,000-ton-per-year smelter comes on-line. This plant could put India into a position of aluminum self-sufficiency. In view of the present consumption pattern, production could outstrip demand for a few years. There was, however, considerable scope for expanding the use of aluminum in India. The producers were aware of the situation and were making efforts to broaden and diversify the usage of aluminum in the country.

The NALCO project is reportedly going to be the seventh largest aluminum plant in the world when it is completed. Construction advanced well during the year but the generally slower than expected progress since 1980 has led to an increase in overall cost from $1.6 billion in 1980 to an estimated $1.9 billion in 1984 dollars. The increase represents a near doubling in terms of rupee costs. The cost increase was due to a rise in prices, change in scope of work, higher customs duties, and increased interest costs on the outstanding loans. The time delays in the project were caused primarily by problems in translating basic engineering specifications from French into workable detailed specifications for the local contractor. In addition, the project was delayed by problems in land acquisition, labor unrest, and relocation of displaced persons.

Nearest to completion of the NALCO complex was the 2.4-million-ton-per-year Panchpatmalli bauxite mine, which will incorporate several firsts for equipment usage in the Indian mining industry. Among them are vacuum suction drilling for faster penetration, more precise sampling, and lower operating costs; 700-horsepower-class bulldozers for ripping overburden; steel chain beadless tires on front-end loaders to reduce tire costs and increase vehicle capabilities; first use of an ANFO truck for on-site explosives mixing and substantially reduced blasting cost; use of articulated rear-dump trucks on steep grades and slippery ground; a double roll-toothed crusher as primary breaker to save energy; and a cable belt conveyor system to transport bauxite 15 kilometers from the mine to the alumina plant.

The public sector BALCO complex at Korba in Madhya Pradesh operated at nearly rated capacity during the year because full electric power was available from the State Electricity Board for the first time. BALCO produced 167,000 tons of alumina and 87,000 tons of aluminum in FY 1984, both of which were company record highs. Although this generated a cash surplus for the year, prospects of sustaining the profit in FY 1985 were poor. There were cost increases for domestic fuel, electric power, production supplies, and Government taxes, which, when combined with the low Government-set selling price, will make it difficult for the company to continue in the black in FY 1985.

HINDALCO embarked on a $85 million plan for modernization and expansion over the next 3 years. The modernization included updating the power and steam generation efficiency, thereby reducing total energy costs by 15%. The expansion is designed to bring aluminum production up to 150,000 tons per year by 1986. By that time, the ongoing expansion of the alumina plant to 300,000 tons per year should also be completed. The company also planned to increase its captive power by at least 70 megawatts in addition to the units installed in 1983.

HINDALCO's 33,000-ton-per-year caustic soda plant, constructed jointly with Bihar State Industrial Development and Investment Corp. (IDCOL) of Orissa Ltd., commenced production in September. Its 7,000-ton-per-year aluminum fluoride facility, built in collaboration with Tamil Nadu Industrial Development Corp., was scheduled for completion by yearend 1985.

The fate of the proposed Andhra Pradesh alumina complex in Vishakhapatnam continued to be uncertain. The complex originally envisaged to have a capacity of 600,000 tons per year was subsequently revised to 800,000 tons per year. However, major problems for the proposed complex were financing and the prospect of a bleak export market for alumina and bauxite. Based on the status at yearend of the aluminum industry, including the ongoing projects, it appeared that the Soviet-assisted Andhra Pradesh alumina complex was likely to be delayed further.

Chromite.—Orissa Mining Corp. (OMC) was near completion of its 50,000-ton-per-year charge chrome plant at yearend. There was a slight delay in construction when the furnace transformer was damaged and had to be sent back to Stromberg, Finland, for repairs. Commissioning and production startup were rescheduled for March 1985. The plant is in Bamnipol, Keonjhar District of Orissa, and will operate under the name of OMC Alloys Ltd.

Indian Metals and Ferro Alloys Ltd. (IMFA) was building a second export-oriented, 50,000-ton-per-year charge chrome plant

that was to be managed as a separate subsidiary, Indian Charge Chrome Ltd. (ICC). The $30 million plant, being put up with assistance from Elkem A/S of Norway, will be at Choudhar, Cuttack District, Orissa. ICC placed a $100 million order with a Swedish firm for a coal-fired thermal power station. Two 54-megawatt turbogenerating units, as well as ancillary equipment, were to be installed and should render the plant independent of Orissa's chronic power problems. Earlier plans called for a 180-megawatt plant. Any surplus power would be fed back to the Orissa power grid.

Ferro Alloys Corp. Ltd. in Balasore District, Orissa, commissioned a new chromium ore concentration plant. The plant was built at its Boula Mine, which adjoins the ferrochromium production plant. The facility was designed to produce 30,000 tons per year of 50% chromium oxide (Cr_2O_3) concentrate from 20% Cr_2O_3 feedstock by gravity separation.

Copper.—The Government-owned Hindustan Copper Ltd. (HCL), the country's only copper producer, currently supplies about one-half of the nation's copper needs—the remainder being imported. This condition was likely to change in future years as continuing exploration added to the copper reserves in the country. The Singhbhum copper belt in southern Bihar currently has five underground mines, but the results of continued exploration beyond the mines indicate a potential for additional commercial deposits in the area. The major hope for significantly increasing copper production, however, came from continued exploration of the Malanjkhand deposit in Madhya Pradesh. Although the surface mine opened in late 1982, exploration drilling has delineated much higher reserves. The most recent estimates put reserves at 790 million tons grading 0.83% copper at a 0.20% copper cutoff. Ore values reportedly were continuing below 580 meters, the depth at which the drilling stopped.

As a result of larger copper reserves, HCL was considering options for its expansion program. Planned increases in the Khetri smelter and refining capacity have been put on hold. Instead, the possibility of adding a smelter and refinery at Malanjkhand was being considered by HCL. A foreign consultant has recommended that HCL consider expansion of the mine production to 14 million tons per year from the present 2 million tons per year and construction of a smelter and refinery to produce 100,000 tons per year of copper. One strong argument for a new smelter was that Malanjkhand's concentrate was being trucked 900 kilometers across India to the Khetri smelter for processing. The high shipping cost would be eliminated if a smelter was built at Malanjkhand. Funding of either project was questionable under present economic conditions.

The Khetri complex has suffered serious production losses over the years because of chronic electric power shortages. In an attempt to solve the problem, HCL has ordered two 10-megawatt gas turbine-powered generator sets from Sweden. The new units would bring captive power at Khetri to 46 megawatts and should meet the full power requirements of the complex. Installation was to be completed by yearend 1985.

HCL installed the world's first electronic ore sorting system for copper at its Khetri complex. The complex was faced with a choice of increasing the concentrator capacity or not using all of the ore the mine could produce. HCL opted for a less expensive shortcut—a highly sophisticated ore sorter supplied by RTZ Ore Sorters Pty. Ltd. of Australia. The sorter takes secondary ore crusher feed of minus 150-millimeter to plus 65-millimeter size. Two streams of ore are deposited on a belt where the conductivity and magnetic properties of the lumps are assessed and relayed to an electronic processor. The lumps pass an optical system that measures their size and position on the belt. The electronic and optical data are then evaluated to determine the grade of each lump. The processor then activates an airblast manifold to deflect the low-grade lumps directly to waste. The system can handle 2,000 tons of ore per day and eliminates an average of 25% of the original feed material.[8]

Ore reserves at the Dariba Mine in Alwar District of Rajasthan were nearing depletion. Dariba has operated at a loss in the past few years. A detailed underground drilling program was begun in 1980 and continued into 1984. By 1983, however, the marginal ore shoots indicated by former surface boreholes had been extended upward from the 320-meter-level drifts. Several sizable ore shoots were mapped, and new reserves of 257,000 tons of 2.2%-grade copper ore were blocked out. Development of the new reserves, referred to as the "Nalla ore block," was expected to extend the life of the mine by 6 to 8 years.[8]

Gold.—Gold was produced in India exclu-

sively in the public sector by the central Government's Bharat Gold Mines Ltd. (BGML) and the Karnataka State government's Hutti Gold Mines Co. Ltd. In addition, a small quantity was recovered as a byproduct in the HCL smelter operations.

India was a major world consumer of gold, used mostly in jewelry. Its production, however, has been small and generally declining since 1971. The problem was one of declining ore grade and increasing costs because of the great depths involved. Since 1880, the ore grade has gone from over 40 grams per ton to an average of 3.4 grams per ton. The output per miner-year has fallen to 80 grams, compared with about 1,150 grams for the average South African miner under similar mining conditions. BGML incurred a loss of $8.5 million in FY 1984, the highest since its nationalization.

In order to increase gold production, BGML was reopening the Yeppamana Mine in the old Ramagiri goldfields in the Anatapur District of Andhra Pradesh. Construction began in November 1981, and trial runs of the mine and mill began in early 1984. The relatively small operation was designed for an ore capacity of 250 tons per day and an annual gold output of just under 300 kilograms.

GSI, Mineral Exploration Corp. (MEC), and BGML have discovered economic gold deposits in the Chigargunta-Mallappakonda area about 30 kilometers south of the Kolar goldfields (KGF). Three blocks have been delineated with an aggregate total of at least 1 million tons of ore grading over 4.3 grams per ton within 200 meters of the surface. Initial mine studies by MEC indicated a startup production of 210 kilograms of gold per year, increasing to 280 kilograms by 1987. Ore would be treated at KGF's mill to utilize spare capacity.

In a further effort to increase overall production, BGML called in a U.S. consultant to develop heap leaching technology for recovering gold from millions of tons of old mill tailings at KGF. It was determined that the yearly treatment of 1 million tons of tailings would yield 500 kilograms of gold. A semicommercial-scale pilot plant was to be set up to determine technical parameters for a large-scale operation. In addition to gold, some of the tailings contain scheelite. The possibility of extracting tungsten from tailings with the highest values was also being studied.

Surveys conducted by the GSI in the Siwalik Belt in Uttar Pradesh and Himachal Pradesh and the States of Punjab, Haryana, and Jammu and Kashmir have indicated some potentially economic placer gold deposits. Terraces along the Markanda and Triokpur Rivers yield spot sampling of up to 1.6 grams of gold per ton. Bulk samples analyzing 0.1 to 0.8 gram per ton were tested in Raigarh District of Madhya Pradesh. Auriferous gravels in the Nilambur Valley of Kerala were being examined for exploitation as well.[7]

Iron and Steel.—The Government-owned Steel Authority of India Ltd. (SAIL) showed a much improved performance during FY 1984. This was achieved mainly through a revival of steel demand, improved inventory management and product mix, and higher capacity utilization owing to fewer electric power outages. SAIL also was able to reduce an unsold inventory of 740,000 tons of steel to a normal average of 100,000 tons by yearend. During the fiscal year, SAIL raised steel prices an average 15% in June 1984 and an additional 15% in February 1985. The first increase helped to drop the huge losses that the public sector steel plants have incurred in recent years to a more manageable level. The second price increase was not in force long enough to affect the industry during the fiscal year. SAIL justified two price increases because of rising raw materials costs. Other problems affecting the industry were the low quality of coking coal and the continuing electric power shortages. SAIL lost 227,000 tons of steel output in April-June 1984 because of power problems. Several steel mills were compensating for the power shortages by installing captive power facilities.

The Indian press made an issue of SAIL's performance during recent years. It was stated that SAIL made a small profit in FY 1984 after a loss of at least $220 million in FY 1983. The press, however, was quick to point out that the central Government had permitted an interest holiday on the steel plant's formidable debts. Also, a favorable rate of depreciation was allowed for Indian steel plants. If the current interest payments had been enforced, the loss reportedly would have been $140 million.

Indian steel development policy called for increasing the present 12.2-million-ton-per-year steel capacity through a combination of modernization of existing and construction of additional plants. Although the sixth 5-year plan (1980-85) envisaged a capacity of 18 million tons in 1985, the actual capacity was unlikely to exceed 14 million tons.

Faced with financial shortages, the Government was according priority for modernization over construction of new plants. In addition, a lower growth in demand for steel than anticipated has lessened the urgency for building additional plants. The expansion and modernization of the Bhilai and Bokaro plants are near completion.

At Bhilai, trial runs of the continuous slab caster began in July 1984 and the oxygen converter shop was beginning to operate smoothly after a several month break-in period. The 3,600 millimeter plate mill, showpiece of the project, was completed in February and was operating satisfactorily. Initial capacity was 950,000 tons per year of high-quality plate, which can be increased to 1.2 million tons when needed.[8] The continuous bloom caster was nearing completion at yearend and scheduled for hot trials in February 1985. In addition, ironmaking and coking facilities were under construction at Bhilai. The overall expansion project was about 2 years behind the original schedule and more than 50% over budget.

Expansion of the Bokaro plant was nearing completion. The fourth blast furnace was completed and operating, and the fifth was scheduled for startup in April 1985, about 9 months behind the current schedule. The second melting shop comprises two 300-ton oxygen converters with a combined capacity of 1.5 million tons per year. The converters were completed in late 1983 and began trial runs early in the year, bringing total raw steel capacity at Bokaro to over 4 million tons per year. In the rolling mill, the new five-stand-tandem, 800,000-ton-per-year, cold-rolling mill was under construction and scheduled for startup in 1986. The sophisticated new mill was designed to roll to a finish thickness of 0.15 millimeter, far thinner than the 0.40-millimeter thickness of the present four-stand mill.[9] In order to mitigate chronic electric power shortages, both Bokara and Bhilai were authorized to install captive power facilities at a cost of $200 million each.

The modernization plan for Durgapur steel mill was cleared by the Public Investment Board during the year. In phase I, updating facilities to be undertaken at the raw material stage included modifications to iron ore beneficiation, improvement in coal washing, augmenting sinter capacity, and updating the blast furnace and steel melting operations. In phase II, an additional blast furnace is to be added. Construction of a captive thermal power station, having two 60-megawatt generators and independent of the mill's modernization plan, was well under way.

The Rourkela steel mill has been the most innovative mill of the Indian steel industry since its construction in 1959. A $140 million silicon steel shop was completed at the plant in 1984. The new facility produced the first domestic cold-rolled grain-oriented and nonoriented specialty steels. The plant will displace about 50,000 tons per year of formerly imported steel. Rourkela also began rolling stainless steel ingots produced at Alloy Steel Plant (ASP) in Durgapur. The unit also began initial Indian production of clad stainless steel sheet and coils. These new products will allow a considerable savings in foreign exchange. Captive power was being installed at Rourkela, which suffered approximately $86 million in lost production from 34 power failures in 1984.

The 3.4-million-ton-per-year Vishakhapatnam steel plant was experiencing both lengthy construction delays and large cost overruns. The plant and infrastructure was originally planned in 1980 to cost $3.3 billion and to begin first-phase operation of 1.2 million tons per year in 1985. Costs have risen steadily on the heavily Soviet-aided project, mainly because the Government did not fund the project at an optimal level. The latest estimates now put the cost at $6.8 billion in 1984 dollars with first-stage completion not before early 1988. Second-stage completion has been put back to 1991. In order to speed up construction, the Indian Planning Commission recommended a 1984 outlay of $680 million, but the Ministry of Finance only allocated $340 million. Continued underfunding of the construction can only lead to additional cost increases. Some steel executives and Government officials reportedly claim that even at 90% utilization capacity the plant could still run large financial losses when or if it is completed. By yearend, the Indian press speculated that the best solution for the Government to minimize its losses would be to abandon the project.

Salem Steel Ltd.'s cold-rolling mill began receiving limited quantities of hot-rolled stainless steel coil from the Rourkela plant. Salem had been completely dependent on high-cost imports, which included an average of 100% ad valorem duty. The 32,000-ton-per-year-capacity plant has been producing only about 7,000 tons per year be-

cause of customer resistance to the price. The customs duty was reduced by one-half at midyear to encourage sales. Domestic coil will not be fully available until 1986.

At Durgapur, ASP was in the middle of a second-stage expansion and updating program. The ladle refining units were to have been completed during the year, but labor problems reportedly have delayed completion to late 1985. The delays have increased the program cost from $58 million to $85 million.

Two States joined fifteen other States that have operating steel minimills or electric arc furnace-based steel mills. Assam Ispat Ltd. began trial production of its 18,000-ton-per-year mill in Amingaon, Assam. Because of its remote location, the plant enjoys 3 to 5 years of concessional power rates, sales, income, and other tax reductions.

Orissa's first miniplant is to come on-line early in 1985 at Gundechapada in Dhenkanal District. It too will have a capacity of 18,000 tons of mild steel ingots. The company has been named Ipisteel Ltd. and was a joint promotion of the Industrial Promotion and Investment Corp. of Orissa and Trident Steel and Industries Partnership.

SAIL and the Public Investment Board have given approval for an iron ore washing plant at Gua Mine in Bihar and a sintering plant at Burnpur. The captive mine of the Indian Iron and Steel Co. (IISCO) over the years has accumulated the world's largest pile of iron ore fines—more than 25 million tons. The Government decided that the pollution problem caused by the fines during monsoon rains had to be stopped. About 1 million tons of new fines are added to the pile each year. The $150 million project was awaiting Union Finance Ministry approval.

Construction of an ore fines handling plant began in February at the Bailadila No. 5 Mine. The plant was to have a 2-million-ton-per-year capacity. About one-half of the fines generated in the mine were being dumped as waste. Construction of a new crushing plant at the Bailadila No. 14 Mine was also started at the same time.

India's scarcity of good coking coal has led to extensive research on methods of steelmaking without coke. In addition, the many steel minimills were faced with a shortage of good melting scrap. The ongoing research on direct-reduction technology has led to several small-scale plants using different technologies.

Orissa Sponge Iron Ltd. began commercial operation of its 150,000-ton-per-year plant in April 1984 at Tangareni, Orissa. Completion of the plant was nearly 1 year late because of severe power shortages. The plant uses a mixture of 80% noncoking coal and 20% petroleum fuels in a process developed by Allis-Chalmers Corp.

The expansion project of Sponge Iron India Ltd. (SIIL), which would double the capacity to 60,000 tons per year, was expected to be completed by yearend 1984. The expansion work was being handled by SIIL's engineering staff. The SIIL plant, which was built for the Government of India (GOI) and the Andhra Pradesh government with United Nations Development Program assistance, has been operating at over 90% of design capacity. Combinations of various raw materials and coal have been tested for Indian and foreign clientel. The consumption of coal has been reduced from 1.9 tons to 1.2 tons per ton of sponge iron produced.[18]

A new private-public company called Ipitata Sponge Iron Ltd. was established to build and operate a sponge iron plant in Keonjhar District of Orissa. Tata Iron and Steel Co. Ltd. (TISCO) and Industrial Promotion and Investment of Orissa were promoting the project. The 90,000-ton-per-year plant was based on TISCO's patented noncoking coal rotary kiln process and scheduled for completion in late 1985.

The Kudremukh iron ore project continued to have problems during 1984. The plant ran at a fraction of rated capacity and supplied modest amounts of concentrate to countries on a test basis. Romania received most of the output as part payment for its aid in erecting the Mangalore pellet plant. The Arab Iron and Steel Co.'s pellet plant in Bahrain was completed at yearend, and Kudremukh received a contract to supply 250,000 tons of concentrate. Czechoslovakia and the Netherlands also have received modest amounts of ore. Negotiations were also under way for sales to France, Japan, and the United Kingdom.

The 3-million-ton-per-year Mangalore pellet plant was scheduled for completion this year but fell behind plans. It was rescheduled for commissioning in mid-1985.

Lead and Zinc.—The Indian demand for lead and zinc, which has been rising 5% per year, far exceeds domestic production. In its long-term plan to increase domestic production, the Government has decided to develop a lead-zinc mine and smelter complex based on the Rampura-Agucha deposit in

Bhilwara District of Rajasthan. Although this was in the sixth 5-year plan (1980-85), financial constraints compelled the Government to defer its implementation. In order to curtail imports, the Secretaries Committee recently approved the project in principle based on commercial borrowing of approximately $525 million. Hindustan Zinc Ltd. (HZL), the Government-owned lead and zinc company, was expected to build the 70,000-ton zinc and 35,000-ton lead smelters at Chanderiya, Chittorgarh District, Rajasthan. A captive powerplant with three 30-megawatt generators was to be included because of chronic power shortages. Metallurgical and Engineering Consultants (India) Ltd. has completed a feasibility report for the project. Total resources at the deposit were set at over 60 million tons with average grades of 13.9% zinc and 1.57% lead. The surface mine would produce and concentrate 2,500 tons per day of ore.

HZL signed an agreement with Cominco Binani Zinc Co. (CBZ) at Binanipuram in Kerala for engineering consultancy work for development and modernization of the CBZ smelter. The program was to add a roaster from Lurgi Corp. of the Federal Republic of Germany, upgrade efficiency of the plant, and increase capacity from 17,000 to 20,000 tons per year. The award of the contract to HZL was significant because it was the first time that HZL had entered into outside consultancy for smelting processes although the company had been doing its own engineering designs for some time.

Completion of these two projects would raise Indian smelter capacity from 92,000 to 165,000 tons per year. Notwithstanding these developments, India would still have to rely on imports to meet the anticipated growth in demand.

In another development, expansion of the Debari smelter and lead residue treatment plant was completed. The smelter capacity was increased from 45,000 to 49,000 tons per year.

Efforts by GSI to locate new reserves continued. Deposits at Siddeswar Kalan, Rajasthan, and Gorabuttan in West Bengal were being explored in detail. The old Ambamata mixed sulfide deposit in Banaskantha District of Gujarat was being reexamined for possible development. A mining lease has been acquired by Gujarat Mineral Development Corp. The 8-million-ton deposit contains relatively good values of lead, zinc, copper, and silver, but the minerals are very fine grained, which may make it difficult to separate economically.

Manganese.—Manganese Ore India Ltd. (MOIL) received a favorable feasibility report, commissioned in 1982, for its proposed 400,000-ton-per-year beneficiation-agglomeration plant. This and the planned 60,000-ton-per-year ferromanganese plant would use the stockpiled and newly generated fines to improve product recovery and quality. Present demand, both domestic and export, is for lump ore only.

In view of the sluggish market for ferromanganese, MOIL was not hurrying to start these projects. It was, however, more seriously considering a 2,500-ton-per-year electrolytic manganese dioxide and a 1,000-ton-per-year electrolytic manganese metal plant. MOIL reportedly was seeking assistance from Kerr-McGee Chemical Corp. of the United States to use its chemical process.

MOIL's other programs included deepening of the Holmes shaft of its Balaghat Mine in Madhya Pradesh, redesigning its Ukwa Mine, and replacing and updating worn-out equipment.[11]

Tungsten.—India's production of tungsten has amounted to only a few dozen tons each year from manual mining of a narrow vein deposit at Degana, in the Nagaur District, Rajasthan. Rajasthan Tungsten Ltd., a State-owned enterprise, was reportedly formed to explore and develop the Oegana deposit. The IBM was to assist with resource calculations and the feasibility study. The main problems were believed to be narrow veins and the very fine-grained occurrence of the wolframite.

Recently, new deposits have been located in Rajasthan at Balda and Devaka-Bera in the Sirohi District. GSI and MEC were conducting exploratory mining to assess the grade and extent of the deposits.

Possible economic deposits of tungsten minerals were reported in the Almora, Chamoli, and Kumaon areas of Uttar Pradesh in the Himalayan foothills. The deposits could be the biggest in the country according to an Uttar Pradesh government geologic report.

In the KGF District, Hutti Gold Mines was considering the potential for recovering scheelite contained in its gold mill tailings. The tailings contain between 0.1% and 0.2% WO_3. Test work was being carried out in the Federal Republic of Germany and by the IBM on the recovery of the scheelite by gravity or flotation to yield a marketable product.[19]

Other Metals.—IDCOL reportedly decided to setup India's first ferronickel plant at Jaipur Road in Cuttack District. IDCOL owns a ferrochrome plant at Jaipur Road and proposed using one of its slag furnaces with suitable modification to produce 4,000 tons of ferronickel per year. The location is near the Sukinda nickel deposit, which contains most of India's known nickel resources. The plant would presumably start operations with imported nickel concentrate. The Sukinda's nickel laterite deposit had been studied for years in an effort to develop an economical process for recovering nickel. Tests to develop an economical process in an experimental Indian-designed pilot plant were unsuccessful.

A molybdenum occurrence was found at Yegavakote in Kolar District, Karnataka, in 1984. The State's Mines and Geology Department reported preliminary analysis of samples grading 0.5% molybdenum. The Department was to undertake a drilling operation to determine the extent of the deposit. There were no molybdenum mines in India.

NONMETALS

Cement.—Installed capacity of the cement industry continued to increase at a rapid rate. About 7 million tons of capacity was added in 1984 in the form of new kilns or by updating existing plants. By the end of the sixth plan (March 1985), capacity was to reach 44 million tons per year. Another 18 million tons of capacity was planned for the seventh plan, much of which was already under construction.[13]

The increase in capacity and production was proving to have some negative as well as obvious positive effects. The increased availability lowered the uncontrolled retail price of the nonlevy cement, leading to lower profits, just as costs of coal and electric power have risen steeply. The cement plant owners had counted on generating money for expansions but profits were doubtful for many. Cement industry representatives contended that the controlled selling price of levy cement was well below the cost of production at many plants.

Several other problems hampered further increases in the output of cement: the chronic electric power shortage, the availability and quality of the coal received for firing the kilns, and the transportation of the coal to the plants. Because of the trend toward higher capacity kilns, shortages of coal or of electric power can cause a complete and costly shutdown. In the past, cement plants could operate at part capacity as each had several kilns of relatively small capacity; with giant one-kiln plants, a supply cutoff shuts down the entire plant. Some of the larger plants have dealt with the power situation by installing captive generating capacity.

The first 100-ton-per-day cement miniplant based on vertical shaft kiln technology, developed by the Regional Research Laboratory at Jorhat, began commercial production in June 1984 at Rajkot, Gujarat. The quality of cement produced by these small plants met all the specifications of the Indian Standards Institute. Six of these plants, with an aggregate capacity of 300,000 tons per year had gone into production by yearend. The Government approved the building of 121 of these plants, often in areas remote from the big rotary-kiln plants or where transportation costs make the local plant more economical. Recent changes in Government regulations could affect the operation of these plants and the construction of the remaining ones. Changes in the freight rates for cement favor the more remote plants. However, employees in the cement miniplants were to be covered by the national wageboard pay scale, which reportedly would triple cement plant costs.

Fertilizer Materials.—Consumption of fertilizers in India has increased significantly during the last 10 years from 2.8 million tons in FY 1973 to 7.2 million tons in FY 1983. Indigenous production of fertilizers, however, totaled only 4.7 million tons in FY 1983. India was thus required to import about $1 billion worth of chemical fertilizer during FY 1983. In order to alleviate this large drain on foreign exchange, the Government began a program for increasing fertilizer capacity using indigenous raw materials. A number of fertilizer plants, which were to utilize natural gas from the offshore Bombay High gasfields, were under construction or in the late planning and design stage. Of particular significance were the six gas-based ammonia-urea plants, which were to be linked by a 1,700-kilometer gas pipeline from Hazira, near Surate, north of Bombay, northward to about 200 kilometers east of New Delhi.

The locations of the six plants, selected by the Government were Bijaipur, near Guna in Madhya Pradesh; Sawai Madhopur in Rajasthan; and Jagdispur, Aonia, Shahjahanpur, and Babrala in Uttar Pradesh. All

plants were to have the same capacity—1,350 tons per day of ammonia and 2,200 tons per day of urea. Furthest along was the Bijaipur plant, started in May 1984, which was to be run by National Fertilizers Ltd. The project cost was estimated at $540 million, much of which was being financed by the International Development Association of the International Bank for Reconstruction and Development (World Bank). Also helping with financing were a Japanese lending agency and the Indian Government. The Indian Government was to hold 50% equity in the Bijaipur plant. Local importers and private firms were to put up the remainder of the capital. The Jagdishpur project, the second plant to be built, was to be a joint venture between Pradeshik Industrial Investment Corp. of Uttar Pradesh and Gulf Consolidated Co. for Services and Industries (GCCSI) of Bahrain. Its cornerstone was laid in October, but the awarding of some contracts was delayed several months reportedly because of problems in obtaining financing from the Indian Government for its 60% equity in this plant. The Aonia project was owned by the Indian Farmers Fertilizer Cooperative Ltd. Contracts were signed for this plant late in the year and construction was to begin in the spring of 1985. The other three projects appeared to be falling behind schedule, mostly because of paperwork and selection of the builders and operators of the projects. The six new plants were to be in major fertilizer consuming areas because of much easier and cheaper transportation of the finished fertilizer. Putting the plants on the coast near Bombay and the gasfield would have put an unacceptable strain on the already crowded transportation system. At yearend, the pipeline that was to serve the plants had not been started.

One naphtha- and three gas-based ammonia-urea plants, unrelated to the six plants above, were under construction during the year. The first phase of Rashtriya Chemicals and Fertilizers Ltd.'s complex at Thal Vaishet in Maharashtra started trial production in October. Commissioning of the plant, which has a capacity of 2,700 tons per day of ammonia and 3,000 tons per day of urea, was scheduled for early 1985. Krishak Bharati Cooperative's plant at Hazira, near Surat, Gujarat, was to be completed by yearend but was rescheduled for a June 1985 startup. It is comprised of two 1,350-ton-per-day ammonia units and four 1,100-ton-per-day urea plants. The Hindustan Fertilizer Corp. Ltd. in Namrup, Assam, was expected to complete a second expansion project in mid-1985 consisting of a 600-ton-per-day ammonia unit and a 1,200-ton-per-day urea plant. This project was originally scheduled to be completed in late 1984. Transportation bottlenecks were the cause for the delay. The Namrup complex has installed a 15-megawatt captive power station to alleviate serious power shortages that affected production since 1981. The fourth plant was the Nagarjuna plant at Kakinada, Andhra Pradesh. It was designed for a capacity of 900 tons per day of ammonia and 1,500 tons per day of urea. Its status was uncertain at yearend.

The phosphate rock, mobile beneficiation pilot plant installed at Jhamarkotra has operated successfully since a full rubber lining was added to resist the hard silicious rock. Use of this plant was helping to develop a suitable flowsheet for a 5,000-ton-per-day beneficiation plant at Jhamarkotra. The results have shown that further development could take place at the numerous very small deposits of rock phosphate that are scattered around India. These deposits were already being used on a small scale as a local source of direct application fertilizer where acid soils can break down the poorly water-soluble phosphate. A mobile plant could be used to greatly increase the utilization of the local resources in a practical and highly beneficial manner.[14]

Gem Stones.—India's diamond exports hit a record $1 billion in FY 1983. During FY 1984, the rate of exports remained about the same as that of FY 1983. Rough diamonds, generally the smaller sizes, are imported, cut, and polished on a small scale by thousands of artisans. The world supply of rough diamonds has been increasing rapidly, and there was concern in the Indian market of an oversupply.

India's first diamond bourse was scheduled to open in Bombay by yearend. To be known as Bharat Diamond Bourse, it will serve as the main center of trade activity where exporters can display their products to the foreign buyers. Minerals and Metals Trading Corp. was instrumental in organizing and setting up the bourse, which will consolidate the diamond trade in Bombay. In past years, the diamond cutting industry has been centered in Gujarat.

India's only sapphire mine at Paddar in the Doda District of the State of Jammu and Kashmir may be reopened after a 7-year closing. A new company was formed com-

prising the State-owned Jammu and Kashmir Minerals Ltd. and the Indian Government-owned National Mineral Development Corp. The deposit was discovered in 1881 and has been worked intermittently since then. The deposit is in rugged terrain and is closed in the winter months. The gem stone occurrence is described as "erratic," making exploitation difficult and highly speculative.

Mica.—Mica mining was one of the few major Indian mineral commodities predominantly in the private sector. The Indian mica mining and trade was mainly an export-oriented industry, with less than 25% of production consumed domestically. To protect the interests of the small miner and to extend its control on this important mineral, the GOI regulated mica trade through its Mica Trading Corp. of India Ltd. (MITCO). MITCO shared with the private sector all exports of crude and processed mica on a 50-50 basis. Its main objectives were to promote exports of processed mica, improve export realization, ensure fair returns to the labor force, and to organize and undertake the fabrication and manufacture of mica products. Apart from routing exports through MITCO, the Government has set minimum export prices for various types of mica.

The volume of mica exports declined in FY 1983, but at the same time, the export earnings from mica rose 17% to $24.8 million. The higher export earnings were attributed to increased imports by the U.S.S.R., which purchased mostly high-priced and high-quality mica. The country-wide port strike in March and April 1984 caused the loss of about $2 million in additional mica sales.

In addition to processed mica, India exports considerable quantities of fabricated and manufactured mica. Very successful marketing efforts by MITCO and the private exporters have doubled the earnings between FY 1979 and FY 1983.

In-line with the Government policy and to take advantage of the market for mica products, MITCO set up a facility for the production of 4,000 tons per year of micronized mica powder and another plant for the manufacture of silvered mica and mica capacitors. In addition, it was setting up a plant for the manufacture of mica paper with an annual capacity of 1,200 tons to be produced by three units. Nippon Rika Kogyosho of Japan was assisting in the construction of a 600-ton-per-year and a 300-ton-per-year unit with an agreement for the Japanese side to buy 50% of the production of the two units. The Government's Bharat Heavy Electrical Ltd. (BHEL) was to design and build the other 300-ton units. Although the first two units were to employ the mechanical disintegration process, the latter was to use the thermochemical process for which BHEL has already prepared a detailed project report. Other plants under consideration included a mica-paper-based products plant, a wet ground mica powder unit, and a glass-bonded mica facility, all of which will require imported technology. All of these projects were being built or planned at Abraknagar in Bihar and were scheduled for commissioning in 1985 against the original schedule of 1984.

MITCO has also initiated a research project to assess the suitability of green mica scrap of Andhra Pradesh for the manufacture of mica paper. The preference worldover for the proven ruby mica scrap of Bihar origin has adversely affected the export of Andhra Pradesh's green mica scrap. The success of the project should benefit the Andhra Pradesh mica industry, which produced mainly the green-quality mica.[15]

Mineral Sands.—Two new deposits of titanium-rich beach sands have been identified. The first, in the Thanjavur District of the State of Tamil Nadu, extended more than 12 kilometers along the Cauvery River delta between Sirkali and Kaveripattinam. Indian Rare Earths Ltd.'s (IREL) analysis suggested a higher content of ilmenite, zircon, monazite, and garnet than the deposit being worked by IREL at Manavalakurichi, 400 kilometers to the south. A detailed investigation was to be conducted to determine the reserves and study the deposition rate. The replenishment from wave action at Manavalakurichi is approximately 50,000 tons per year.[16]

The second deposit was found by the National Institute of Oceanography (NIO) during a survey off the Konkan coastal area of Maharashtra. The occurrence of onshore ilmenite placers along 200 kilometers of the coast had been known for many years. In 1983 and 1984 offshore exploration, NIO identified large reserves of ilmenite in 13 to 20 meters of water over a 436-square-kilometer area. Maharashtra mining officials estimated the reserves between Undi and Purnagad, a distance of 48 kilometers, at 4 million tons. The survey showed that the ilmenite placers were on the seafloor for

the first 2 to 5 kilometers offshore then continue below a clay layer further offshore.

IREL's Orissa sand complex at Chatarpur made progress toward opening during the year. The long-delayed startup was rescheduled for mid-1985. The 2.8-million-ton-per-year dredge and wet concentrator plant was completed with Australian collaboration. The complex was designed to produce 200,000 tons per year of ilmenite, 10,000 tons of natural rutile, 4,000 tons of monazite, and 3,000 tons of zircon. In addition, 30,000 tons of byproduct sillimanite per year would double the country's production of that mineral.

The dryer section, electromagnetic sand separation plant, and acid regeneration plant were due to be completed in mid-1984. The major sections still to be completed were the rare-earths chemical plant and the 100,000-ton-per-year synthetic rutile plant.

Meanwhile, Kerala Minerals & Metals Ltd.'s 22,000-ton-per-year titanium dioxide pigment plant in Kerala was nearing completion. The $100 million project was set up in three stages: the synthetic rutile plant, the acid recovery plant, and the titanium dioxide pigment plant. Stages one and two were ready for commercial production during 1984, but the third stage was not expected to be completed until 1985.

Renovation began on the rare-earths plant of IREL at Alwaye, Kerala, and completion was scheduled for 1986.[17]

Stone and Clay.—Many of the active marble quarries in Rajasthan and several other States were threatened with closure by recent Government decisions affecting the operations of the industry. Marble mining employed 21,000 workers in more than 1,000 quarries in 1982 and had expected to increase employment to 32,000 by 1985. Output of finished stone more than doubled since 1982. The recent introduction of close-tolerance diamond gang-saws into the Indian marble industry has enabled a better quality stone to be produced at prices competitive with the world famous Italian polished marbles.

Several recent Government actions, however, have combined to jeopardize the profitability of the quarry and marble processing operations. First, late in 1983, the Rajasthan State government increased the royalty on marble mining from $2.67 to $9.70 per ton, cutting heavily into mine profits.

Secondly, the central Government has lifted the ban on imports of Italian marble. The Rajasthan Marble Processors Association (RMPA) wanted it reinstated because sales of its famous Makrana marble declined 40% since the ban was lifted. RMPA claimed that polished Italian marble pasted over with plaster was being brought into the country as raw marble slabs. Lastly, the central Government reportedly imposed an excise duty on processed marble blocks, slabs, and tiles. The rate was set at $4.24 to $5.08 per square meter. Nearly 70% of production was ordinary marble selling at $6.36 to $9.15 per square meter. The All-India Marble Processors Association claimed that the cost of the new tax would price marble beyond the reach of most of their regular customers. The Association claimed that nearly 200 of the marble quarries or processors have already closed.[18]

An export-oriented ceramic tile plant was being set up at Yenam near Kakinada in technical and financial collaboration with an Italian firm. Using a new technology for the first time in India, the clay-drying cycle was reduced to 45 minutes with a fuel savings of 40%. The $10 million plant was to be owned by Regency Ceramics Ltd. and have a capacity of 30,000 tons of finished tile per year.[19]

Sulfur.—India has no commercial native sulfur deposits. Sulfur was produced as a byproduct from sulfide ore, petroleum refining, and a small amount from roasting iron pyrite. A $5 million sulfur recovery plant was nearly completed at Hindustan Petroleum Corp.'s Chembur refinery. The hydrogen-sulfide-rich gases were expected to save about $190,000 per year in imported sulfur. Seven hydrogen sulfide oxidation plants have been ordered for the Hazira area north of Bombay. Each plant will be able to treat 5 million cubic meters per day of sour natural gas and recover 12.5 tons of elemental sulfur daily. The first three plants were to be installed immediately, while the installation of the remainder were to be spread over the next 2 years. The 32,000 tons of combined sulfur output per year would more than double India's current output from iron pyrite.[20]

MINERAL FUELS

Coal.—Coal production reached a record high in FY 1984, and output was 7% over that of FY 1983. Coal India Ltd. (CIL), the main Government-owned coal producer con-

tributed 131 million tons. The remainder came from Singareni Collieries Co. Ltd. (SCCL) and the captive mines of two steel companies.

There was an encouraging increase in productivity as output per worker shift for CIL reached 0.82 ton. SCCL's rate increased also to 0.68 ton. During the year, the Government sanctioned the development of 12 new coal mines with a cumulative capacity of 14.8 million tons per year and a capital outlay of $370 million. In addition, 14 previously approved mines were nearing completion. The intention of the Government was to reach a production of 236 million tons by the end of the seventh plan period. About 100 million tons of this could be from far more efficient surface mines, compared with the present level of 65 million tons from surface mines.

In order to improve the quality of the coal going to the steel mills, a Government working group on coal recommended construction of 15 additional coal washers. This would raise the total number of washers to 39 and increase the raw coal input capacity from 33 million to over 60 million tons by the end of the seventh plan. To finance the production increases and the coal washers, the Department of Coal had proposed an investment of $9 billion during the plan period, several times the investment of the current period.

A change in transportation policy was proposed by the coal department and the railroads. The mines would deliver coal to central storage dumps in State capitals and major industrial centers from where the consumers would take delivery of the coal. It was believed that this proposal would eliminate most of the problem in the coal transport system. Direct linkages from the mines to the electric powerplants was to be retained.

Several projects were completed or begun in 1984. The 1.2-million-ton-per-year Nandan coal washer in Chhindwara District of Madhya Pradesh began trial runs in June. The plant was designed to reduce ash content below 17%, enabling it to supply clean coking coal to the Bhilai steel plant and middlings to the nearby powerplants.

Development of the huge $275 million Amlohri coal mine in the Singrauli Coalfield began in March. The project was receiving technical and financial aid from the United Kingdom. Coal production was to begin after removal of 50 million cubic meters of overburden. Initially, the mine was to supply 4 million tons per year of coal to the Rihand superthermal powerplant. The mine's ultimate capacity was to be 10 million tons per year, the quantity needed to operate the powerplant at its designed capacity of 3,000 megawatts. First-phase startup of both mine and powerplant was scheduled for 1986.[21]

The Soviet Union and India signed a protocol for cooperation in new coal projects in the seventh plan period. The new projects include a surface mine in Jharia Coalfield in Bihar with a capacity of 8.8 million tons of coking coal, the nearby Sitamala Mine with a capacity of 2.2 million tons of coking coal, and the Mohar Mine at the Singrauli Coalfield with an 11-million-ton-per-year capacity of powerplant coal.

Development of the 1.2-million-ton-per-year Satgram underground mine began at yearend. The mine was to be constructed with Polish technical assistance.

Petroleum and Natural Gas.—Oil and Natural Gas Commission (ONGC) and Oil India Ltd. (OIL) are the Government-owned companies responsible for oil exploration and production. Both accelerated their oil search and development efforts during the year. OIL in particular has expanded its once modest role of production of oil from the Assam fields to that of a full-fledged exploration company. The accent on exploration stemmed from the Government's continuing policy of increasing long-term domestic petroleum production and reducing expensive oil imports.

Crude oil production has risen impressively during the sixth 5-year plan period (FY 1980-84). The rate of increase, however, has slowed in the last few years, reflecting that no new large oilfields have been discovered since the Bombay High-area bonanza.

ONGC had three discoveries in 1984: a natural gas strike at the Bhimanpalli One well in the onshore section of the Krishna-Godavari Basin, an oil strike in the Gulf of Kutch near the Pakistan border, and an onshore oil strike near Cambay in Gujarat State. All of these will require additional evaluation to determine if they are commercially exploitable.

OIL had less luck in its exploration activity. Six wells were drilled in the offshore Mahanadi Basin, none of which showed evidence of hydrocarbons. OIL planned to continue its onshore search in Assam and its new concessions in the Thar desert of Rajasthan and onshore Mahanadi. It has also applied for an exploration license for

an area north of the Brahmaputra River near Pasighat in Assam and for another near its present block in Arunachal Pradesh. OIL also plans to explore offshore around the Anadaman and Nicobar Islands in a tract previously held by ONGC.

ONGC planned a greatly increased exploration budget for the seventh plan period. It would concentrate on the Krishna-Godavari Basin offshore.

In addition to its own exploration work, the Indian Government was also considering allowing foreign firms to form joint ventures with private Indian companies.

OIL's production sector was planning to rehabilitate the Digboi Oilfield in Assam. The 95-year-old field, one of the oldest continuously producing fields in the world, needed to have most of its old equipment overhauled or replaced in order to continue operating. OIL was likely to seek technical assistance from the French for the project.[22]

India's refining capacity has kept up well with the increases in crude oil production during the last decade. Total refining capacity was 37.8 million tons with the opening of the Mathura Refinery in 1982. Continued expansion was to raise the capacity to 45.5 million tons by yearend 1984.

The Cochin refinery in Kerala was due to complete an expansion project in 1984 but an explosion and fire in March set the project back. The capacity was to be increased from 3.3 million to 4.5 million tons per year. Of more significance than the new capacity was the installation of fluid catalytic cracking (FCC) equipment, which enabled the use of Bombay High crude oil and increased the production of middle distillates.

The Visakhapatnam refinery was being expanded to 4.5 million tons per year in a first-stage expansion scheduled for mid-1985 completion. A second stage of construction was to include an FCC unit and liquefied petroleum gas production facilities. Refineries at Madras and Bombay were also being expanded and were to get FCC units as well. The long-planned Haldia refinery expansion, however, was shelved indefinitely.

GOI, through its newly formed Gas Authority of India Ltd., planned to build the country's largest pipeline, 1,700 kilometers from Hizira through Bejaipur to Jagdishpur. Bids for various sections of the pipeline and for equipment were called for in March. Construction was to start no later than midyear, but delays and changes on bidding, financing, and basic policy decisions have set the entire project back at least 1 year. The plan was to develop the South Bassein offshore gasfield and bring the gas 230 kilometers to shore in a 91-centimeter pipeline. It would then travel 1,700 kilometers to Jagdisphur, servicing six large gas-based nitrogen fertilizer complexes and some proposed thermal or gas turbine powerplants on the way. The delayed start of construction was almost certain to affect the startup of at least the Bijaipur plant, which was scheduled for a December 1986 commissioning. Failure to have the pipeline completed in time could leave several billion dollars worth of fertilizer capacity idle.

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[1]Physical scientist, Division of International Minerals.
[2]The Indian fiscal year runs from Apr. 1 of the year stated.
[3]Where necessary, values have been converted from Indian rupees (Rs) to U.S. dollars at the rate of Rs9.65=US$1.00 in 1982, Rs10.3=US$1.00 in 1983, and Rs11.8=US$1.00 in 1984.
[4]The New Sketch. V. 44, No. 36, June 4, 1984, p. 17.
[5]Engineering and Mining Journal. V. 185, No. 6, June 1985, p. 40.
[6]Indian Mining and Engineering Journal. V. 29, No. 1, Jan. 1985, p. 3.
[7]Indian News. V. 24, No. 5, Apr. 29, 1985, p. 5.
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